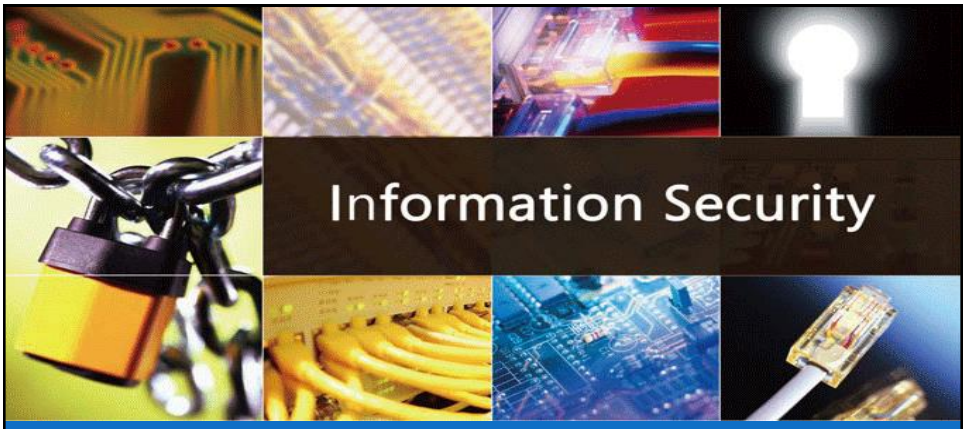


Authentication

Lecturer: Nguyễn Thị Thanh Vân – FIT - HCMUTE

Objective

- Understand the importance of authentication
- Learn how authentication can be implemented
- Understand threats to authentication

Contents

- Introduction
- Electronic User Authentication Principles
- Password-Based Authentication
- Token-Based Authentication
- Biometric Authentication
- Remote User Authentication
- Security Issues for User Authentication

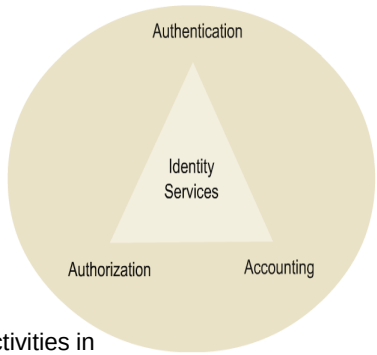
AAA architectures

- AAA is an architectural framework for configuring:

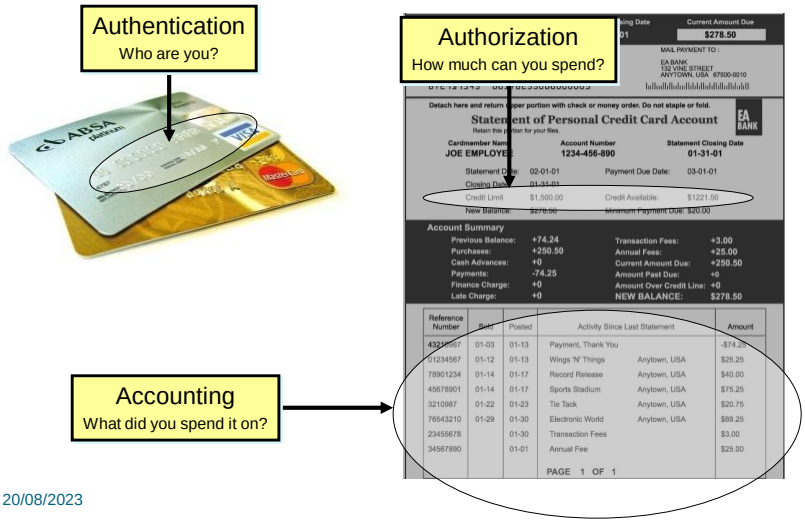
Authentication - **Who is allowed access?**
Verification that the credentials of a user or other system entity are valid

Authorization - **What are they allowed to do?**
The granting of a right/permission to a system entity to access a system resource

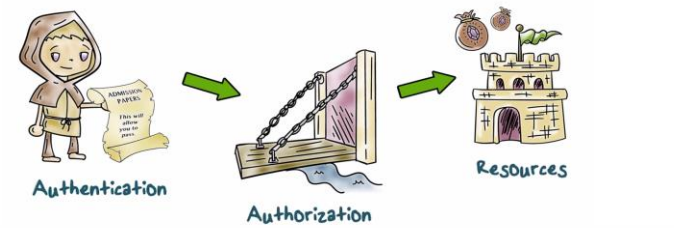
Accounting - **What did they do?**
examination of system records and activities in order to test for adequacy of system controls, to ensure compliance with established policy and operational procedures



AAA architectural



What is Authentication?



Authentication Goals

- Availability:
  - when the correct credentials are presented, the resources should be made available to the processor (on behalf of the user).
- No false negatives:
  - if a process presents incorrect credentials but is given access
  - These should not happen.
- No false positives:
  - if a process presents the correct credentials but is denied access
  - These should not happen either

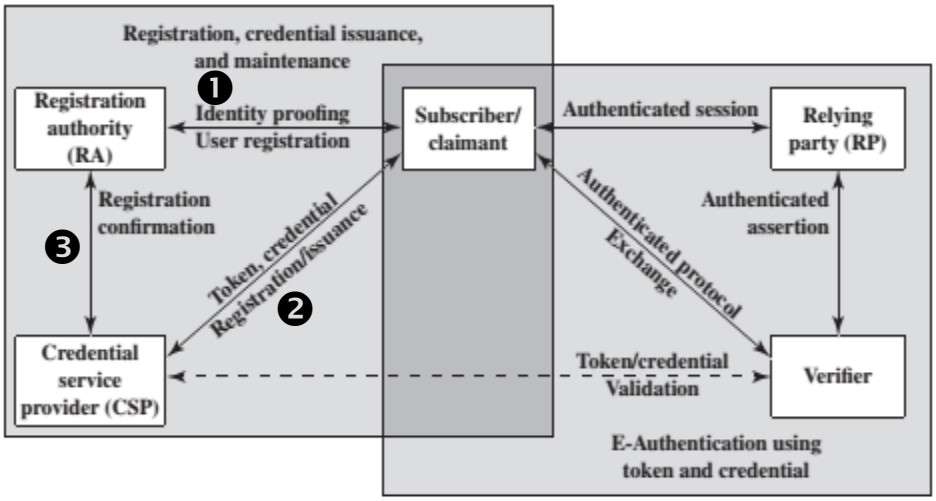
Login Attacks Quiz

Check the correct answer from the choices.

An attacker correctly guesses Alice's password and logins in as her. Is this a case of...

- ☐ False negative
- ☐ True positive
- ☐ False positive
- ☐ True negative

Authentication Architectural Model



Authentication Quiz

Check the correct answer from the choices.

We now have personal devices that are not shared across multiple users. What threats motivate the use of authentication in such devices?

- ☐ Malware infection that may exfiltrate sensitive data
- ☐ Loss of theft of the device

The evolution of authentication technology

The evolution of authentication technology

- 1961: Password (Fernando J. Corbató, MIT): storing plaintext passwords
- Late 1960s: password encryption (Robert Morris, Bell Labs.) hash of password
  - extremely difficult to crack. Hackers can build password scanners.
- 1980s: Dynamic Passwords
  - The passwords change based on factors such as time, location, or physical password updates.
  - Two dynamic password protocols: Time-based one-time (OTP) and HMAC based OTP.
- Late 1990s: Public Key Infrastructure
  - Transport Layer Security protocol - TLS
  - Late 1990s, Taher Elgamal - an engineer at Netscape - developed Secure Sockets Layer (SSL)
- 2000s: multi-factor authentication and single sign-on
- 2010s: Biometrics
  - In 2011, the Motorola ATRIX Android was the first mobile device to feature a fingerprint scanner.
  - Apple is behind the times with Touch ID technology. By 2017, Apple had a FaceID technology,
  - Biometric authentication technology provides a higher level of security and convenience
- Decades of 2020: Passwordless Authentication
  - use the authentication key (physical key, virtual key application on smartphones) then activate the biometric key for authentication.
  - Big technology trend, inevitable of the future because of outstanding benefits in enhancing security efficiency, ex Apple, Microsoft, Samsung, Amazon, ...

Means of Authentication

Something the individual knows

Password
PIN,
Answer

Something the individual process

Smart card
Physical key
Token

Something the individual is (Static biometrics)

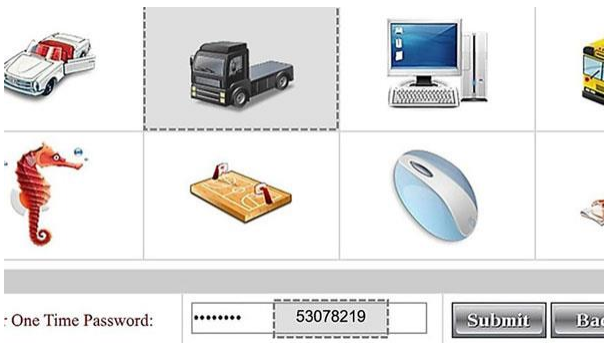
fingerprint
retina,
Face
iris

Something the individual does (Dynamic biometric)

Voice, gait
Handwriting
Typing rhythm

Means of Authentication

- GOTPass: users employ “images and a one-time numerical code” in order to secure password.
  - using patterns and images instead of letters and numbers
  - the generated digits random code



Authentication Methods

- Authentication: Verifies user access to the operating system
- Physical authentication:
  - Allows physical entrance to company property
  - Magnetic cards and biometric measures
- Digital authentication: verifies user identity by digital means
- Digital certificates: identifies and verifies holder of certificate
- Digital token (security token):
  - Small electronic device
  - Displays a number unique to the token holder;
  - Uses a different password each time
- Digital card: Also known as a security card or smart card
  - Similar to a credit card; uses an electronic circuit instead of a magnetic strip
  - Stores user identification information
- Kerberos:
  - Developed by MIT
  - Uses tickets for authentication purposes

15

Authentication Methods (continued)

- Lightweight Directory Access Protocol (LDAP):
  - Developed by the University of Michigan
  - A centralized directory database stores:
    - Users (user name and user ID)
    - Passwords
    - Internal telephone directory
    - Security keys
  - Efficient for reading but not suited for frequently changing information
- NT LAN Manager (NTLM):
  - Developed and used by Microsoft
  - Employs a challenge/response authentication protocol
- Public Key Infrastructures (PKI):
  - User keeps a private key
  - Authentication firm holds a public key
  - Encrypt and decrypt data using both keys

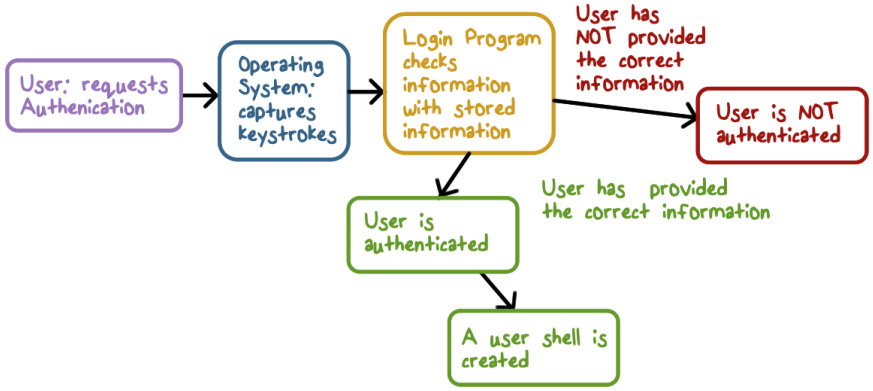
16

Authentication Methods (continued)

- RADIUS: used by network devices to provide a centralized authentication mechanism
  - **RADIUS provides:** Authentication, Authorization, Accounting
- Secure Socket Layer (SSL): authentication information is transmitted over the network in an encrypted form
- Secure Remote Password (SRP):
  - Password is not stored locally
  - Invulnerable to brute force or dictionary attacks

17

How is Authentication Implemented?



Risk Assessment for User Authentication

- Assurance level: the degree of confidence
  - **Level 1:** Little or no confidence in the asserted identity's validity.
  - **Level 2:** Some confidence in the asserted identity's validity.
  - **Level 3:** High confidence in the asserted identity's validity
  - **Level 4:** Very high confidence in the asserted identity's validity.
- Potential impact: potential impact on organizations r individuals should there be a breach of security
  - Low: adverse effect on organizational operation
  - Moderate: serious adverse effect
  - High: severe or catastrophic adverse effect
- areas of risk.: mapping between the potential impact and the appropriate level of assurance

Risk Assessment for User Authentication

- areas of risk.

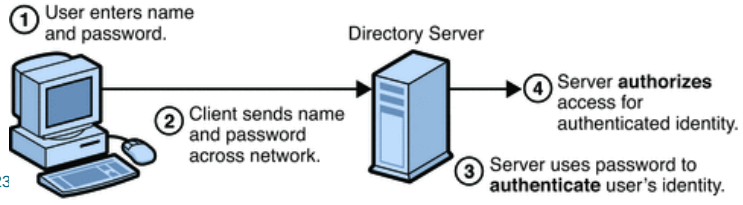
	Assurance Level Impact Profiles			
Potential Impact Categories for Authentication Errors	**1**	**2**	**3**	**4**
Inconvenience, distress, or damage to standing or reputation	Low	Mod	Mod	High
Financial loss or organization liability	Low	Mod	Mod	High
Harm to organization programs or interests	None	Low	Mod	High
Unauthorized release of sensitive information	None	Low	Mod	High
Personal safety	None	None	Low	Mod/ High
Civil or criminal violations	None	Low	Mod	High

Means of Authentication

- **Password-Based Authentication**
  - The Vulnerability of Passwords
  - The Use of Hashed Passwords
  - Dynamic Passwords
  - Passwordless authentication
- **Token-Based Authentication**
- **Biometric Authentication**

Password-Based Authentication

- The password systems defense against intruders
- Systems require: user provide name or ID + password
  - all multiuser systems,
  - network-based servers,
  - Web-based e-commerce sites,
  - and other similar services
- The password serves to authenticate the ID of the individual logging on to the system.



The Vulnerability of Passwords

1. Offline dictionary attack:

- A hacker gain access to the system password file.
- Compares the password hashes against hashes of commonly used passwords.

2. Specific account attack:

- Attacker targets a specific account &submits password guesses until the correct password is discovered.

3. Popular password attack / Against single user:

- The attacker chooses a popular password and tries it.
- Attacker attempts to gain knowledge about the account holder and system password policies and uses that knowledge to guess the password.

The Vulnerability of Passwords

4. Workstation hijacking:

- The attacker waits until a logged-in workstation is unattended.

5. Exploiting user mistakes:

- User is more likely to write it down passwords, because it is difficult to remember.

6. Exploiting multiple password use.

- Similar password for a many applications

7. Electronic monitoring:

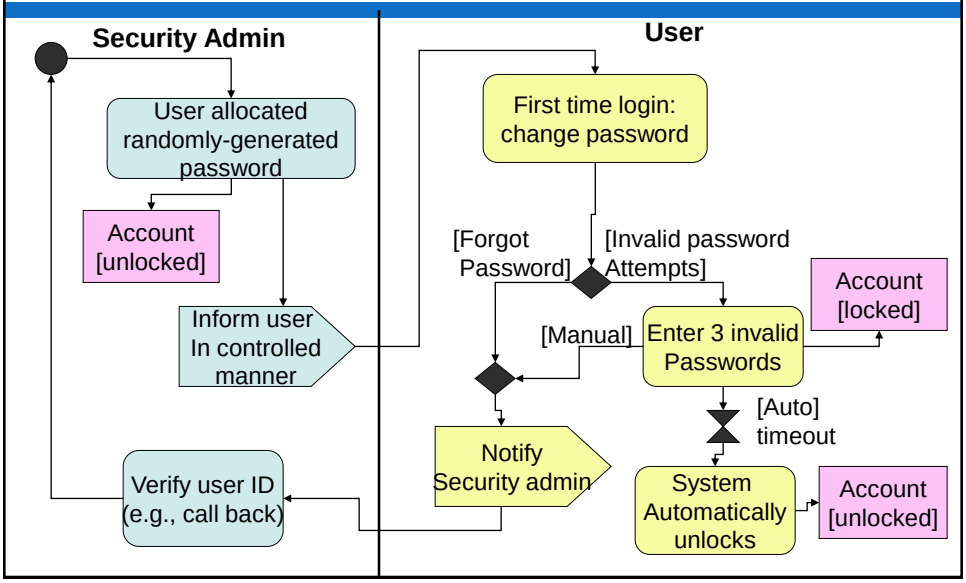
- If a password is communicated across a network to log on to a remote system, it is vulnerable to eavesdropping.

Password Popularity Quiz

Check which passwords made the top 10 most common passwords for 2014:

- ☐ 123456
- ☐ password
- ☐ letmein
- ☐ abc123
- ☐ 111111
- ☐ 696969
- ☐ 123123
- ☐ batman
- ☐ qwerty
- ☐ 123456789

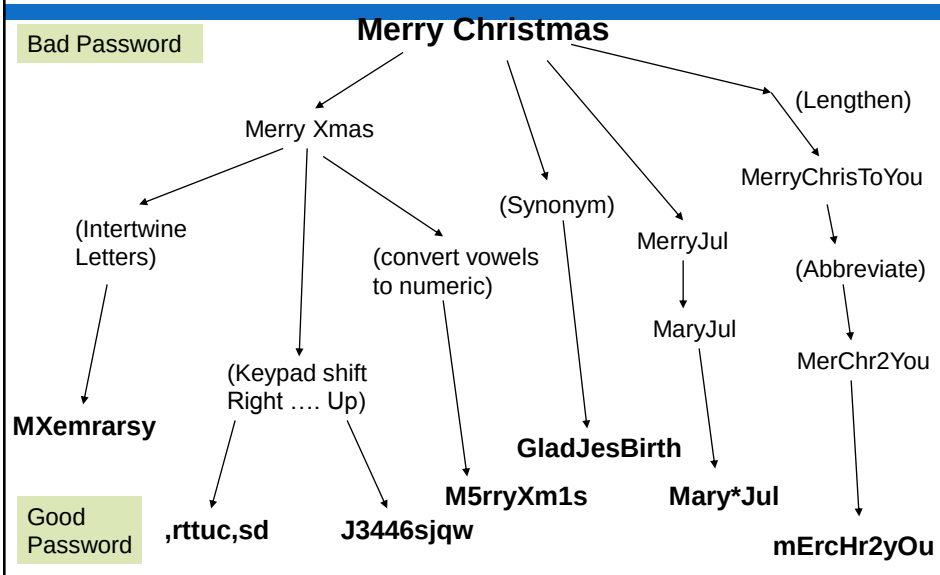
Recommended Password Allocation



Password Rules

- One-way encrypted using a strong algorithm
- Never written down and retained near terminal or in desk
- should be changed every 30 days, by notifying user in advance
- A history of passwords should prevent user from using same password in 1 year
- Passwords should be >= 8 (better 12) characters, including 3 of: alpha, numeric, upper/lower case, and special characters
- Passwords should not be identifiable with user, e.g., family member or pet name
- Four basic techniques are in use:
  - User education
  - Computer-generated passwords
  - Reactive password checking
  - Complex password policy

Creating a Good Password



Admin & Login ID Rules

- Restrict number of admin accounts
- Admin password should only be known by one user
- Admin accounts should never be locked out, whereas others are
- Admin password can be kept in locked cabinet in sealed envelope, where top manager has key
- Login IDs should follow a confidential internal naming rule
- Common accounts: Guest, Administrator, Admin should be renamed
- Session time out should require password re-entry

Single Sign On

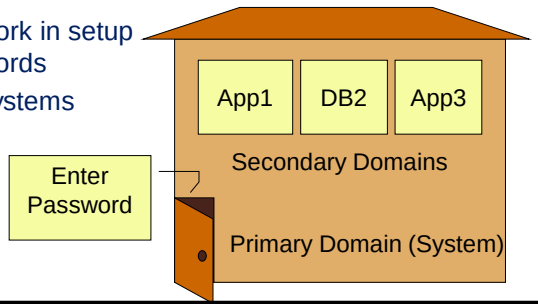
Single Sign On (SSO) is the ability for a user to enter the same id and password to logon to multiple applications within an enterprise.

Advantages

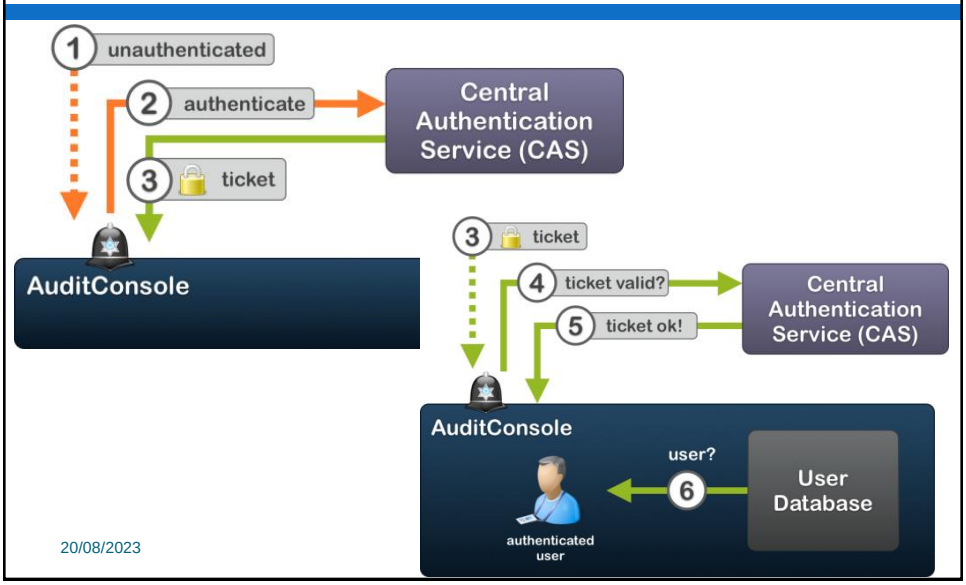
- One good password replaces lots of passwords
- IDs consistent throughout system(s)
- Reduced admin work in setup & forgotten passwords
- Quick access to systems

Disadvantages

- Single point of failure -> total compromise
- Complex software development due to diverse OS
- Expensive



Central Authentication Service (CAS)



Implementing Password Authentication

How do we check the password supplied with a user id?

Method 1 - store a list of passwords, one for each user in the system file.

- The file is readable only by the root/admin account
- What if the permissions are set incorrectly?
- Why should admin know the passwords?
- If security is breached, the passwords are exposed to an attacker.

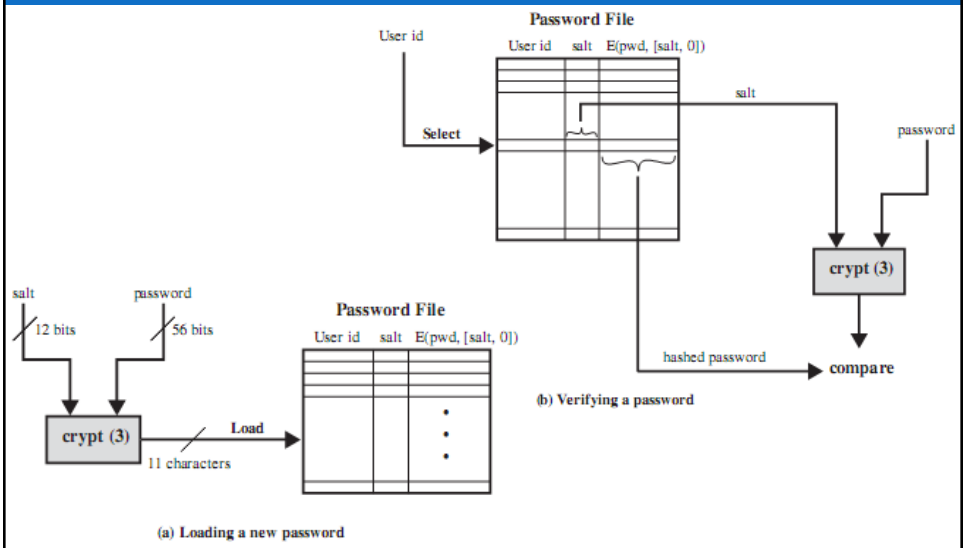
Implementing Authentication

How do we check the password supplied with a user id?

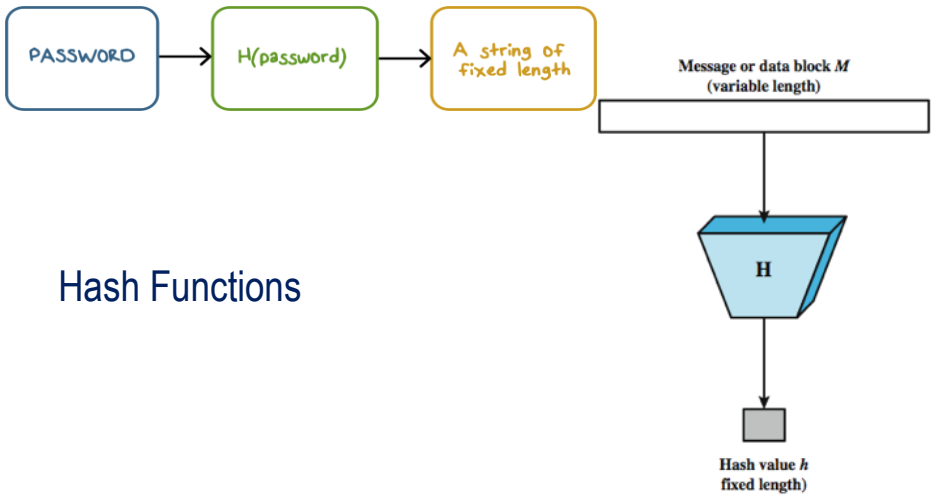
Method 2 - do not store passwords, but store something that is derived from them

- Use a one-way hash function and store the result
- The password file is readable only for root/admin

UNIX Password Scheme



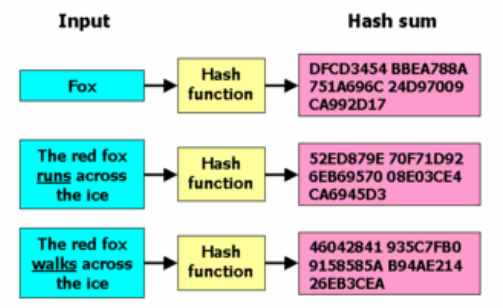
The Use of Hashed Passwords



Hash Functions

What is Hash Functions

- A hash function maps a *variable-length message* into a *fixed-length hash value*,
  or message digest
  $h = H(M)$
- The *principal object:*
  - *data integrity*



- Problems: hackers could build programs to brute-force guess passwords. To combat this, computer scientists came up with dynamic passwords.

Public Key Infrastructure

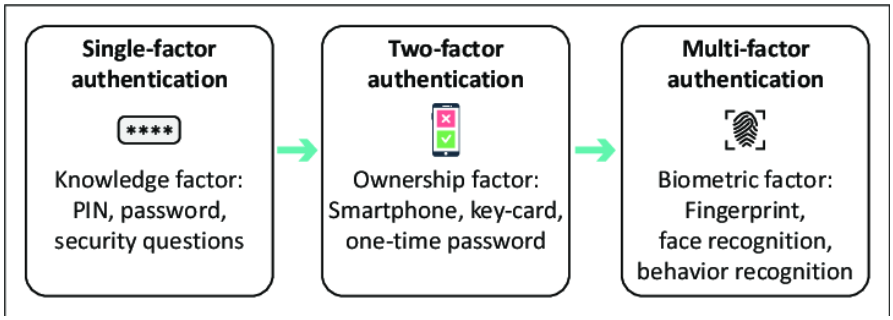
- Symetric cryptography
- Asymmetric cryptography was developed in the ‘70s but kept secret until 1997
- Every PKI must include:
  - Certificate authority () = Issuer of digital certificates (including signing)
  - Registration authority () = Verifier of identities requesting digital certificates
  - Central directory = Where keys are stored
  - Certificate management system = Structure for operations, such as accessing stored certifications
  - Certificate policy = Statement of PKI requirements

Dynamic Passwords

- Two dynamic password protocols:
  - TOTP = Time-based OTP where the uniqueness of the OTP is generated based on the current time.
  - HOTP = HMAC-based OTP where the uniqueness of the OTP is generated based on the hash of the previous password.

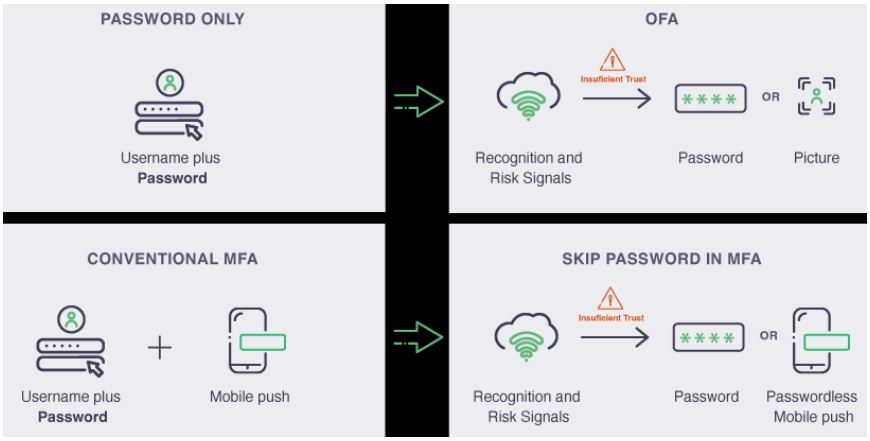
- These passwords change based on variables, like location, time, or a physical password update (like a FOB).
- They remove any risk of and solve the problem caused when users have the same password in many places.
- It’s very common for dynamic passwords to be used in conjunction with regular passwords as a form of two-factor authentication (2FA).
- Multi-factor authentication (MFA) a little later, but it’s important to note that it did appear as early as the ‘80s

Multi-factor authentication



Passwordless authentication

- Evaluate Recognition and Risk Signals to skip Passwords

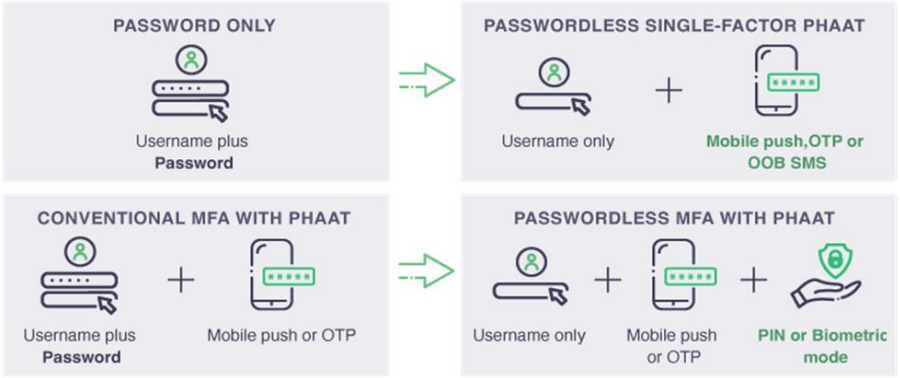


Passwordless authentication

- Passwordless authentication
  - In the late 2010s () began to become known.
  - However, it was not until the early 2020s that this technology was applied to many platforms.
- Characteristic
  - use the authentication key (physical key, virtual key application on smartphones) then activate the biometric key for authentication.
  - It is a big technology trend of the future because of outstanding benefits in enhancing security efficiency,
  - a major trend that inevitably creates the future for secure strong authentication when most of the world's large corporations are developing and using this technology such as Apple, Microsoft, Samsung, Amazon.

Passwordless authentication

- Two mainstream methods for directly replacing password authentication.
  - The first is to use the phone-as-a-token (PHAAT) method.
  - Secondly, both single-factor and multi-factor authentication (MFA) can be modelled to authenticate without the use of passwords.
- Adopt Passwordless phone-as-a-token authentication:



Means of Authentication

- **Password-Based Authentication**
  - The Vulnerability of Passwords
  - The Use of Hashed Passwords
  - Dynamic Passwords
  - Passwordless authentication
- **Token-Based Authentication**
- **Biometric Authentication**

Token-Based Authentication

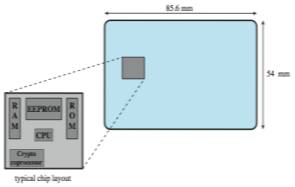
- You must have them
- May require additional hardware (e.g., readers)
- How does it implement authentication (challenge/response)
- Cost and misplaced trust (RSA SecureID master key breach)
- Types:
  - Memory card
  - Token

Memory Cards

- Memory cards can store only a simple security code
  (not process data).
- The bank card: a magnetic stripe on the back.
- Using memory card:
  - Alone
  - + PIN
- Among the potential drawbacks
  - **Requires special reader:** increases the cost hardware and software.
  - **Token loss:** determine the PIN to gain unauthorized access
  - **User dissatisfaction:** use for computer access

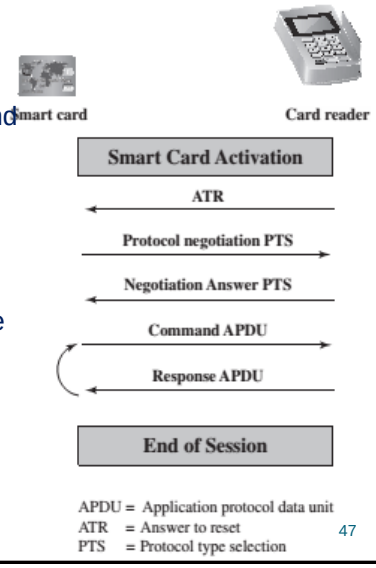
Smart Cards

- Has own processor, memory, I/O ports
  - Wired or wireless access by reader
  - May have crypto co-processor
  - ROM, EEPROM, RAM memory
- Executes protocol to authenticate with reader/computer
  - Static:
  - Dynamic password generator:
  - Challenge-response:
- Also have USB dongles



Smart Card/Reader Exchange

- Each time the card is inserted
  - a reset is initiated (clock value)
  - the card responds (the parameters and protocols).
  - The terminal may be able to change the protocol used and other parameters via a protocol type selection (PTS) command.
  - The cards PTS response confirms the protocols and parameters to be used.
  - The terminal and card can now execute the protocol to perform the desired application.

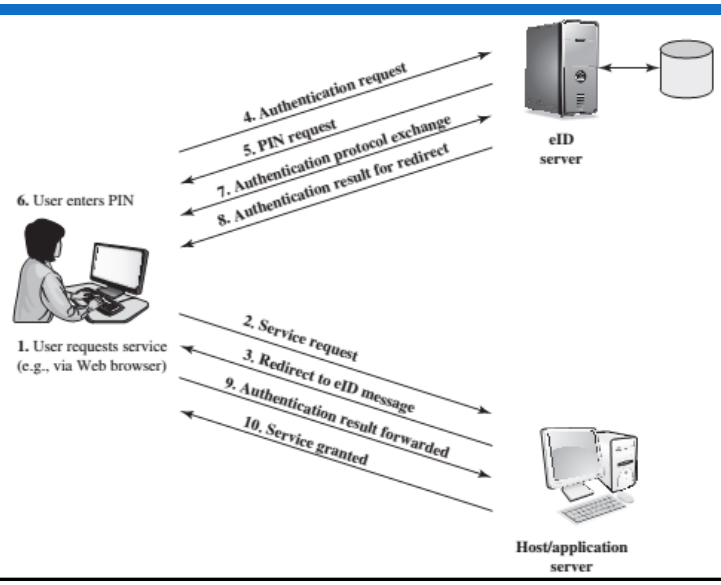


APDU = Application protocol data unit
ATR = Answer to reset
PTS = Protocol type selection

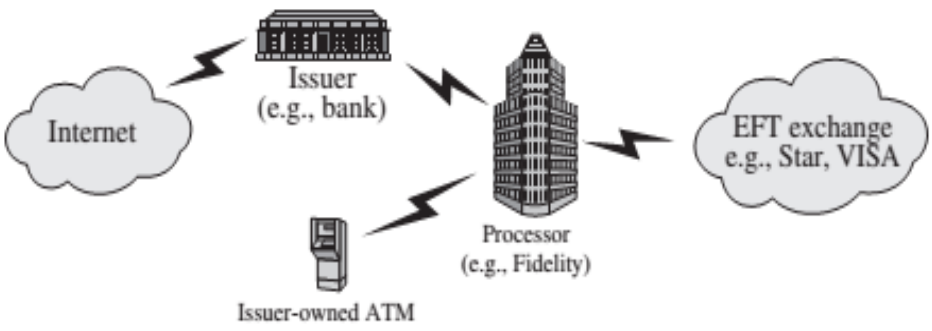
Electronic Identity Cards

- A smart card as a national identity card for citizens
- A national electronic identity (eID)
  - national ID cards
  - driver's license
- an eID card has been verified by the national government as valid and authentic.
- Functions:
  - **ePass:** stores a digital representation of the cardholder's identity. (electronic passport)
  - **eID:** stores an identity record that authorized service can access
  - **eSign:** stores a private key and a certificate verifying the key

User authentication eID

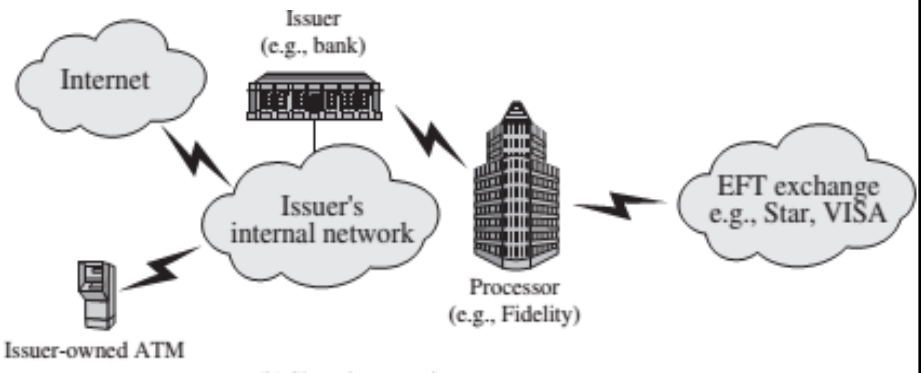


Ex, ATM architectures



(a) Point-to-point connection to processor

Ex, ATM architectures



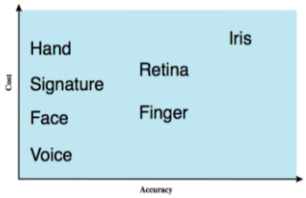
(b) Shared connection to processor

Means of Authentication

- **Password-Based Authentication**
  - The Vulnerability of Passwords
    The Use of Hashed Passwords
- **Token-Based Authentication**
- **Biometric Authentication**

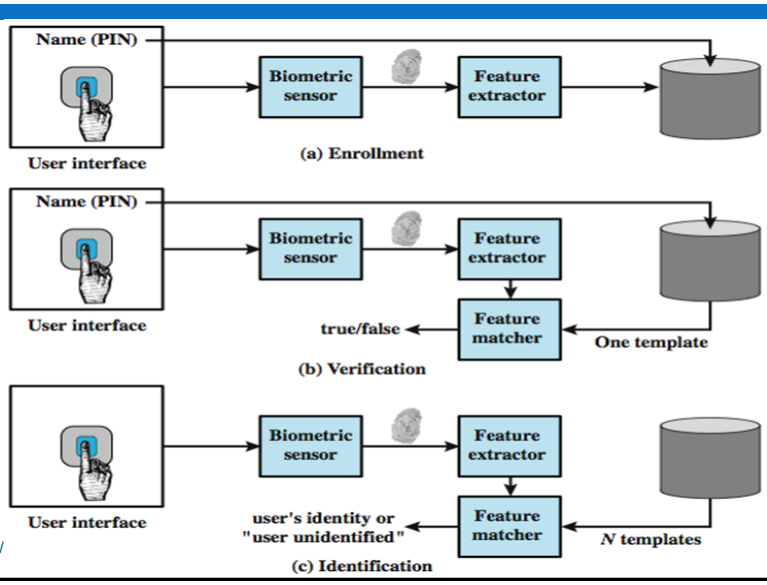
Biometric authentication

- based on pattern recognition.
- more complex and expensive.

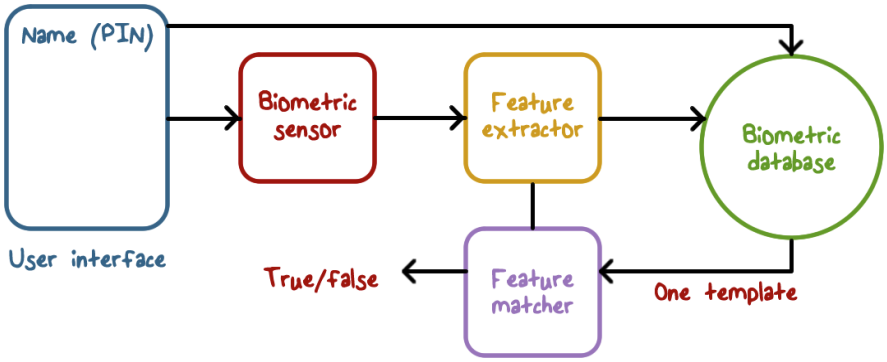


Characteristic	Fingerprints	Hand geometry	Retina	Iris	Face	Signature	Voice
Ease of use	High	High	low	Medium	Medium	High	High
Error incidence	Dryness, dirt, age	Hand injury	Glasses	Poor lighting	Lighting, age, glasses, hair	Changing signatures	Noise, colds, weather
Accuracy	High	High	Very high	Very high	High	High	High
User acceptance	Medium	Medium	Medium	Medium	Medium	Very high	High
Required security level	High	Medium	High	Very high	Medium	Medium	Medium
Long term stability	High	Medium	High	High	Medium	Medium	Medium

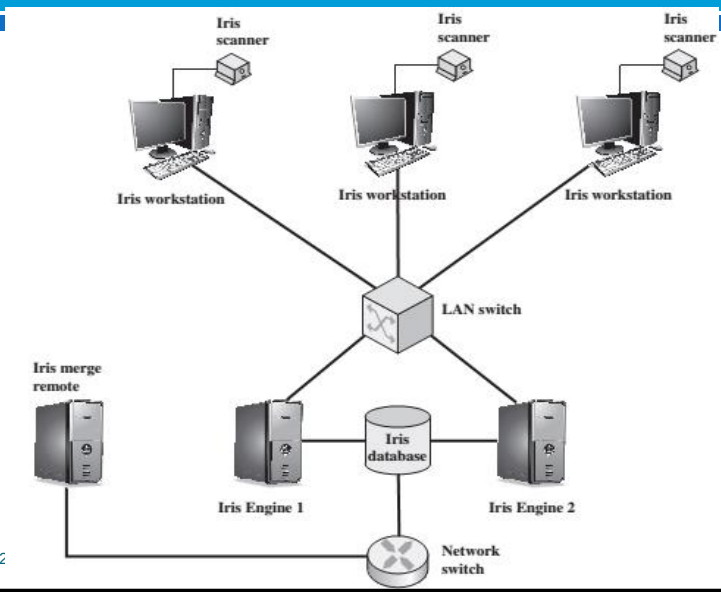
Operations of a Biometric Authentication System



Implementing Biometric Authentication



Ex: General Iris Scan Site Architecture for UAE System



Other Authentication Methods

Multi-factor authentication

- Uses more than one method
- Type password but also send a code via SMS
  - It goes to your phone (something you have)
  - Gmail implements this
- ATM card and a PIN
- Other things like your location
- **Attacker must defeat both to compromise authentication**

Multi-factor Authentication Quiz

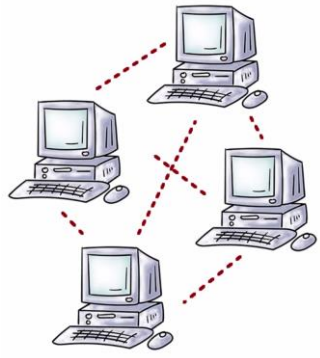
A multi-factor authentication method will likely reduce false negative. Choose one:

☐ True

☐ False

Other Authentication Methods

Authentication over a network:

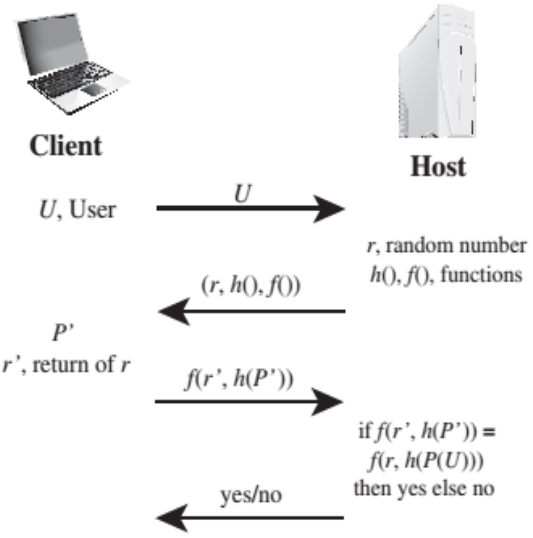


- Do we always have a trusted path to the OS we need to authenticate to?
  - **Remote services**
- Network authentication **introduces new problems**
- Need crypto to secure network communication
- **Other attacks** (man-in-the-middle)

Remote user authentication

- More security threats with remote user authentication
  - an eavesdropper being able to capture a password
  - an adversary replaying an authentication sequence that has been observed
- Systems generally rely on some form of challenge-response protocol.
- Protocols:
  - Password Protocol
  - Token protocol
  - Biometric protocol

Password Protocol



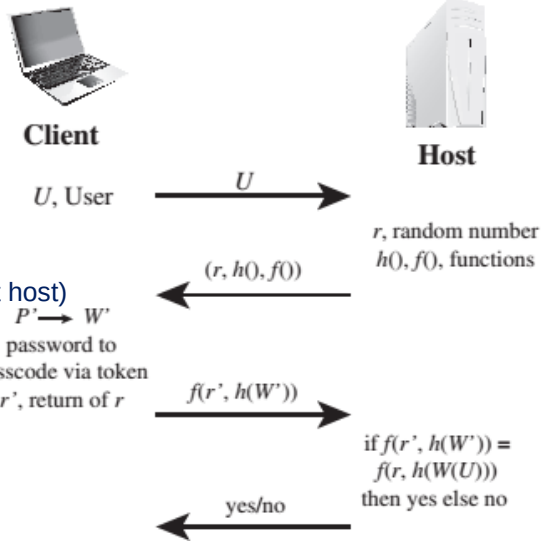
Token protocol

- Passcode W'

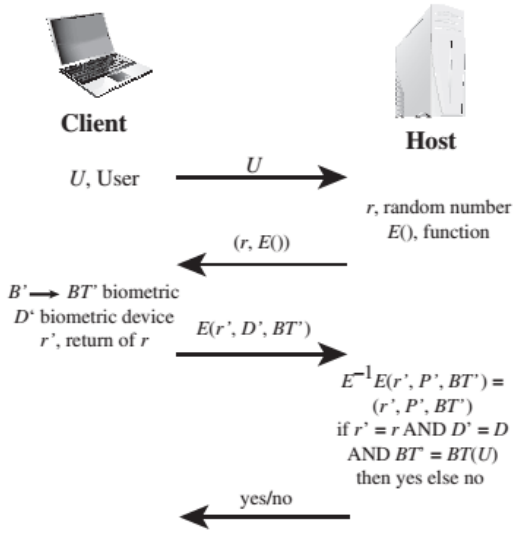
(synchronized with host)

- Password P'

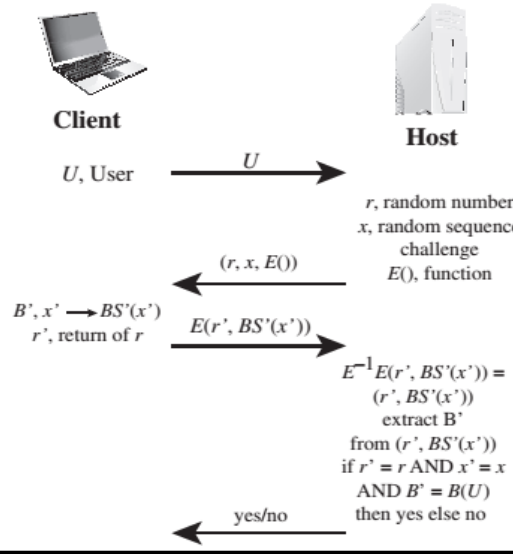
(shared user and token, not host)



Static biometric protocol



Dynamic biometric protocol



Security Issues for User Authentication

Attacks	Authenticators	Examples	Typical Defenses
Client attack	Password	Guessing, exhaustive search	Large entropy; limited attempts
	Token	Exhaustive search	Large entropy; limited attempts; theft of object requires presence
	Biometric	False match	Large entropy; limited attempts
Host attack	Password	Plaintext theft, dictionary/exhaustive search	Hashing; large entropy; protection of password database
	Token	Passcode theft	Same as password; 1-time passcode
	Biometric	Template theft	Capture device authentication; challenge response

Security Issues for User Authentication

Eavesdropping, theft, and copying	Password	"Shoulder surfing"	User diligence to keep secret; administrator diligence to quickly revoke compromised passwords; multifactor authentication
	Token	Theft, counterfeiting hardware	Multifactor authentication; tamper resistant/evident token
	Biometric	Copying (spoofing) biometric	Copy detection at capture device and capture device authentication
Replay	Password	Replay stolen password response	Challenge-response protocol
	Token	Replay stolen passcode response	Challenge-response protocol; 1-time passcode
	Biometric	Replay stolen biometric template response	Copy detection at capture device and capture device authentication via challenge-response protocol
Trojan horse	Password, token, biometric	Installation of rogue client or capture device	Authentication of client or capture device within trusted security perimeter
Denial of service	Password, token, biometric	Lockout by multiple failed authentications	Multifactor with token

Authentication in IIS

- ✓ Anonymous Authentication: ko dùng username/pass
- ✓ Basic Authentication: Có dùng username/pass (plaintext)
- ✓ Digest Authentication: u/p có mã hóa
- ✓ Windows Authentication: Dùng kỹ thuật băm (NTLM or Kerberos protocols) để xác nhận thông tin của users.
- ✓ Client Certificate Mapping Authentication

Server tạo ra các giấy Client Certificate và yêu cầu Client khi truy xuất tới Server thì phải gởi giấy chứng nhận.

- ✓ Forms Authentication

Cho phép user logon vào một form (html logon page) để chứng thực

- ✓ ASP.NET Impersonation Authentication

Có thể dùng ứng dụng ASP.NET dưới sư bảo mật khác với bảo mật mặc định của ASP.NET

LAB

- Install and configure IIS in Windows and use authentication types
- Install and configure Apache in Linux and use authentication types (digest and Basic)

Summary

- Introduction
- Electronic User Authentication Principles
- Password-Based Authentication
- Token-Based Authentication
- Biometric Authentication
- Remote User Authentication
- Security Issues for User Authentication